animal cell

plant cell

Eukaryotes complex organisms
contains all the parts of animal cells plus extras

permanent vacuole
contains cell sap
keeps cell turgid, contains sugars and salts in solution

Cell differentiation
how a cell changes and becomes specialised
Undifferentiated cell are called STEM cells

animal cell differentiation

plant cell differentiation

All stages of life cycle the stem cells are grouped together in meristems

Cytoplasm
site of chemical reactions in the cell
gel like substance containing enzymes to catalyse the reactions

nucleus
contains genetic material
controls the activities of the cell and codes for proteins

cell membrane
semi permeable
controls the movement of substances in and out of the cell

ribosome
site of protein synthesis
mRNA is translated to an amino acid chain

mitochondrion
site of respiration
where energy is released for the cell to function

Bacterial cells are much smaller than plant and animal cells

AQA
Cell Structure

Prokaryotes simpler organisms

nerve
carry electrical signals
long branched connections and insulating sheath

sperm
fertilise an egg
streamlined with a long tail acrossome containing enzymes large number of mitochondria

muscle
contract to allow movement
contains a large number of mitochondria long

root hair
absorb water and minerals from soil
hair like projections to increase the surface area

xylem
carry water and minerals
TRANSPIRATION - dead cells cell walls toughened by lignin flows in one direction

phloem
carry glucose
TRANSLOCATION - living cells cells have end plates with holes flows in both directions

Feature
Radiation used
Max magnification
Resolution
Size of microscope
Cost

Light (optical) microscope
Light rays
~ 1500 times
200nm
Small and portable
~£100 for a school one

Electron microscope
Electron beams
~ 2 000 000 times
0.2nm
Very large and not portable
Several £100,000 to £1 million plus

 PREFIXES
Prefix
centi (cm)
milli (mm)
micro (μm)
nano (nm)
Multiple
1 cm = 0.01 m
1 mm = 0.001 m
1 μm = 0.000 001 m
1nm = 0.000 000 001 m
Standard form
× 10^-2
× 10^-3
× 10^-6
× 10^-9

magnification M = \frac{\text{size of image I}}{\text{real size of the object A}}
**Cell biology 2**

- **Cell**: The smallest structural and functional unit of an organism.
- **Nucleus**: A structure that contains genetic material and controls the activities of the cell.
- **Chromosome**: A thread-like structure of coiled DNA found in the nucleus of eukaryotic cells.
- **DNA**: A polymer made up of two strands forming a double helix.
- **Gene**: A section of DNA that codes for a specific protein or characteristic.

**Mitosis and the cell cycle**

- **Stage 1: Growth**: Increase the number of sub-cellular structures e.g. ribosomes and mitochondria.
- **Stage 2: DNA Synthesis**: DNA replicates to form two copies of each chromosome.
- **Stage 3: Mitosis**: One set of chromosomes is pulled to each end of the cell and the nucleus divides. Then the cytoplasm and cell membranes divide to form two cells that are identical to the parent cell.

**Adaptations for diffusion**

- **Diffusion**: No energy required. Movement of particles in a solution or gas from a higher to a lower concentration. E.g. O$_2$ and CO$_2$ in gas exchange, urea in kidneys. Factors that affect the rate are concentration, temperature, and surface area.
- **Osmosis**: No energy required. Movement of water from a dilute solution to a more concentrated solution. E.g. Plants absorb water from the soil by osmosis through their root hair cells. Plants use water for several vital processes including photosynthesis and transporting minerals.
- **Active transport**: ENERGY required. Movement of particles from a dilute solution to a more concentrated solution. E.g. movement of mineral ions into roots of plants and the movement of glucose into the small intestines.

**Stem cells**

- **Undifferentiated cell of an organism**: Can be cloned and made to differentiate into most cell types.
- **Human Embryonic stem cells**: Can be cloned and made to differentiate into most cell types. Therapeutic cloning uses same genes so the body does not reject the tissue. Can be a risk of infection.
- **Adult bone marrow stem cells**: Can form many types of human cells e.g. blood cells. Tissue is matched to avoid rejection, risk of infection. Only a few types of cells can be formed.
- **Meristems (plants)**: Can differentiate into any plant cell type throughout the life of the plant. Used to produce clones quickly and economically, e.g. rare species, crop plants with pest/disease resistance.

**Small intestines**

- Villi – increase surface area, Good blood supply – to maintain concentration gradient, Thin membranes – short diffusion distance.

**Lungs**

- Alveoli – increase surface area, Good blood supply – to maintain concentration gradient, Thin membranes – short diffusion distance.

**Gills in fish**

- Gill filaments and lamella – increase surface area, Good blood supply – to maintain concentration gradient, Thin membranes – short diffusion distance.

**Roots**

- Root hair cells - increase surface area.

**Leaves**

- Large surface area, thin leaves for short diffusion path, stomata on the lower surface to let O$_2$ and CO$_2$ in and out.

**Treatment with stem cells may be able to help conditions such as diabetes and paralysis. Some people object to the use of stem cells on ethical or religious grounds.**
The activity of enzymes is affected by changes in temperature and pH. Enzymes have an optimum temperature and an optimum pH for best activity. Large changes in temperature or pH can stop the enzyme from working (denature) - temperature too high or pH too high or too low. Enzymes catalyse (increase the rate of) specific reactions in living organisms due to the shape of their active site. The 'lock and key' theory is a simplified model to explain enzyme action.
**Blood**

Blood is a tissue consisting of plasma, in which blood cells, white blood cells and platelets are suspended.

<table>
<thead>
<tr>
<th>Plasma (55%)</th>
<th>Pale yellow fluid</th>
<th>Transports CO₂, hormones and waste.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red blood cells (45%)</td>
<td>Carries oxygen</td>
<td>Large surface area, no nucleus, full of haemoglobin.</td>
</tr>
<tr>
<td>White blood cells (&lt;1%)</td>
<td>Part of the immune system</td>
<td>Some produce antibodies, others surround and engulf pathogens.</td>
</tr>
<tr>
<td>Platelets (&lt;1%)</td>
<td>Fragments of cells</td>
<td>Clump together to form blood clots.</td>
</tr>
</tbody>
</table>

**AQA GCSE ORGANISATION part 2**

**Lungs and gas exchange**

The heart pumps low oxygen/high carbon dioxide blood to the lungs.

**Blood vessels**

**Artery**
- Carry blood away from the heart

**Vein**
- Carry blood to the heart

**Capillary**
- Connects arteries and veins

**Heart**

The heart is an organ that pumps blood around the body in a double circulatory system.

- **Right ventricle**
  - Pumps blood to the lungs where gas exchange takes place.

- **Left ventricle**
  - Pumps blood around the rest of the body.

- **Pacemaker (in the right atrium)**
  - Controls the natural resting heart rate. Artificial electrical pacemakers can be fitted to correct irregularities.

- **Coronary arteries**
  - Carry oxygenated blood to the cardiac muscle.

- **Heart valves**
  - Prevent blood in the heart from flowing in the wrong direction.

**Trachea**
- Carries air to/from the lungs
- Rings of cartilage protect the airway.

**Bronchioles**
- Carries air to/from the air sacs (alveoli)
- Splits into multiple pathways to reach all the air sacs.

**Alveoli**
- Site of gas exchange in the lungs
- Maximises surface area for efficient gas exchange.

**Capillaries**
- Allows gas exchange between into/out of blood
- Oxygen diffuses into the blood and carbon dioxide diffuses out.

**Gas exchange in an alveolus**

- CO₂ out
- O₂ in
- red blood cells

**Blood**

- Carries oxygen

**Bronchiolus** (air sacs at the end)

**Capillary**

**Diaphragm**

**Lungs and gas exchange**

The heart is an organ that pumps blood around the body in a double circulatory system.
### AQA GCSE INFECTION AND RESPONSE part 1

#### Plants have several ways of defending themselves from pathogens and animals

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical</td>
<td>Thick waxy layers, cell walls stop pathogen entry</td>
</tr>
<tr>
<td>Mechanical</td>
<td>Thorns, curling up leaves to prevent being eaten</td>
</tr>
<tr>
<td>Chemical</td>
<td>Antibacterial and toxins made by plants</td>
</tr>
</tbody>
</table>

#### Detection and Identification of Plant Diseases (Bio Only)

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stunted growth</td>
<td>Reference using gardening manual or website, laboratory test for pathogens, testing kit using monoclonal antibodies.</td>
</tr>
<tr>
<td>Spots on leaves</td>
<td>Nitrates ions needed for protein synthesis – lack of nitrates = stunted growth.</td>
</tr>
<tr>
<td>Area of decay</td>
<td>Magnesium ions needed to make chlorophyll – not enough leads to chlorosis – leaves turn yellow.</td>
</tr>
<tr>
<td>Malformed stem/leaves</td>
<td>Presence of pests</td>
</tr>
</tbody>
</table>

#### Pathogens May Infect Plants or Animals and Can Be Spread by Direct Contact, Water or Air

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Disease</th>
<th>Symptoms</th>
<th>Method of Transmission</th>
<th>Control of Spread</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virus</td>
<td>Measles</td>
<td>Fever, red skin rash</td>
<td>Droplet infection from sneezes and coughs</td>
<td>Vaccination as a child</td>
</tr>
<tr>
<td>Virus</td>
<td>HIV</td>
<td>Initially flu like systems, serious damage to immune system.</td>
<td>Sexual contact and exchange of body fluids</td>
<td>Anti-retroviral drugs and use of condoms.</td>
</tr>
<tr>
<td>Virus</td>
<td>Tobacco mosaic virus</td>
<td>Mosaic pattern on leaves.</td>
<td>Enters via wounds in epidermis caused by pests.</td>
<td>Remove infected leaves and control pests that damage the leaves.</td>
</tr>
<tr>
<td>Bacteria</td>
<td>Salmonella</td>
<td>Fever, cramp, vomiting, diarrhoea.</td>
<td>Food prepared in unhygienic conditions or not cooked properly.</td>
<td>Improve food hygiene, wash hands, vaccinate poultry, cook food thoroughly.</td>
</tr>
<tr>
<td>Bacteria</td>
<td>Gonorrhoea</td>
<td>Green discharge from penis or vagina.</td>
<td>Direct sexual contact or exchange of body fluids.</td>
<td>Use condoms. Treatment using antibiotics.</td>
</tr>
<tr>
<td>Fungus</td>
<td>Rose black spot</td>
<td>Purple black spots on leaves.</td>
<td>Spores carried via wind or water.</td>
<td>Remove infected leaves. Spray with fungicide.</td>
</tr>
</tbody>
</table>

#### Bacteria May Produce Toxins That Damage Tissues and Make Us Fall Ill

<table>
<thead>
<tr>
<th>Viruses</th>
<th>Bacteria (prokaryotes)</th>
<th>Protists (eukaryotes)</th>
<th>Fungi (eukaryotes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>e.g. cold, influenza, measles, HIV, tobacco mosaic virus</td>
<td>e.g. tuberculos (TB), Salmonella, Gonorrhoea</td>
<td>e.g. dysentery, sleeping sickness, malaria</td>
<td>e.g. athlete’s foot, thrush, rose black spot</td>
</tr>
</tbody>
</table>

#### Non-specific Defence Systems

- White blood cells are part of the immune system
- The human body has several non-specific ways of defending itself from pathogens getting in

#### Specific Defence Systems

- Antigens (surface protein) identified by white blood cells
- Bacteria may produce toxins that damage tissues and make us ill

### DNAs or RNA surrounded by a protein coat

- No membrane bound organelles (no chloroplasts, mitochondria or nucleus).
- Cell wall. Single celled organisms

### Pathogens Are Microorganisms That Cause Infectious Disease

- Viruses live and reproduce inside cells causing damage

### Human Defence Systems

- Physical
- Chemical
- Mechanical

### Pathogens are identified by white blood cells by the different proteins on their surfaces ANTAGENS.
Traditionally drugs were extracted from plants and microorganisms

- **Digitalis**
  - Extracted from foxglove plants and used as a heart drug
- **Aspirin**
  - A painkiller and anti-inflammatory that was first found in willow bark
- **Penicillin**
  - Discovered by Alexander Fleming from the Penicillium mould and used as an antibiotic

Antibiotics and painkillers

- **Antibiotics**
  - Kill infective bacteria inside the body. Specific bacterial infections require specific antibiotics.
  - **e.g. penicillin**
- **Painkillers and other medicines**
  - Drugs that are used to treat the symptoms of a disease. They do not kill pathogens
  - **e.g. aspirin, paracetamol, ibuprofen**

**Diagnosis**

- **Monoclonal antibodies** can be used in a variety of ways
  - **Diagnosis**
  - Can detect very small quantities of chemicals in the blood
  - **Detecting molecules**
  - Fluorescent dye can be attached so it can be seen inside cells or tissues
  - **Treatment**
  - Bound to radioactive substance, toxic drug or chemical
  - Cancer cells are targeted to normal body cells are unharmed

**Vaccination**

- Used to immunise a large proportion of the population to prevent the spread of a pathogen

**New drugs are synthesised by chemists in the pharmaceutical industry**

- Most new drugs are synthesised by chemists in the pharmaceutical industry
- **Clononal antibodies** can be used in a variety of ways

**Diagnosis and drug development**

- **AQA INFECTION AND RESPONSE**
  - **Small amount of dead or inactive form of the pathogen**
  - **1st infection by pathogen**
  - White blood cells detect pathogens in the vaccine. Antibodies are released into the blood.
  - **Re-infection by the same pathogen**
  - White blood cells detect pathogens. Antibodies are made much faster and in larger amounts.

**Clinical trials use healthy volunteers and patients**

- **Stage 1**
  - Healthy volunteers try small dose of the drug to check it is safe and record any side effects
- **Stage 2**
  - A small number of patients try the drug at a low dose to see if it works
- **Stage 3**
  - A larger number of patients; different doses are trialled to find the optimum dose
- **Stage 4**
  - A double blind trial will occur. The patients are divided into groups. Some will be given the drug and some a placebo.

**Drug have to be tested and trialled before to check they are safe and effective**

- **Efficacy**
  - Make sure the drug works
- **Toxicity**
  - Check that the drug is not poisonous
- **Dose**
  - The most suitable amount to take

**Preclinical trials - using cells, tissues and live animals - must be carried out before the drug can be tested on humans.**

**Clinical trials use healthy volunteers and patients**

- **Stage 1**
  - Healthy volunteers try small dose of the drug to check it is safe and record any side effects
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**A placebo can look identical to the new drug but contain no active ingredients**

**A person is unlikely to suffer the symptoms of the harmful disease and its spread in a population is prevented**

**Antibiotics cannot be used to treat viral pathogens**

- It is difficult to develop drugs to kill viruses without harming body tissues because viruses live and reproduce inside cells

**Antibiotics have greatly reduced deaths from infectious bacterial disease**

- Bacteria can mutate
  - Sometimes this makes them resistant to antibiotic drugs.

- Antibiotics have greatly reduced deaths from infectious bacterial disease
  - **Antibiotics**
    - e.g. penicillin
  - Kill infective bacteria inside the body. Specific bacterial infections require specific antibiotics.
  - **Painkillers and other medicines**
    - Drugs that are used to treat the symptoms of a disease. They do not kill pathogens
    - **e.g. aspirin, paracetamol, ibuprofen**
Plants use the glucose produced in photosynthesis in a variety of ways:

- Respiration, stored as insoluble starch, fats or oils for storage, cellulose for cell walls, combine with nitrates from the soil to form amino acids for protein synthesis.

Photosynthesis

Plants make use of light energy from the environment (ENDOTHERMIC) to make food (glucose)

\[
\text{CO}_2 + \text{H}_2\text{O} \xrightarrow{\text{light}} \text{O}_2 + \text{C}_6\text{H}_{12}\text{O}_6
\]

The rate of photosynthesis is affected by temperature, light intensity, carbon dioxide concentration, and the amount of chlorophyll.

<table>
<thead>
<tr>
<th>Factor</th>
<th>How the rate is affected</th>
<th>Limiting factors (why the rate stops going up)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>As the temperature of the environment the plant is in increases rate of photosynthesis increases (up to a point) as there is more energy for the chemical reaction.</td>
<td>Photosynthesis is an enzyme controlled reaction. If the temperature increases too much, then the enzymes become denatured and the rate of reaction will decrease and stop.</td>
</tr>
<tr>
<td>Light intensity</td>
<td>Light intensity increases as the distance between the plant and the light sources increases. As light intensity increases so does the rate of photosynthesis (up to a point) as more energy is available for the chemical reaction.</td>
<td>At point X another factor is limiting the rate of photosynthesis. This could be carbon dioxide concentration, temperature or the amount of chlorophyll.</td>
</tr>
<tr>
<td>Carbon dioxide concentration</td>
<td>Carbon dioxide is needed for plants to make glucose. The rate of photosynthesis will increase when a plant is given higher concentrations of carbon dioxide (up to a point).</td>
<td>At point X another factor is limiting the rate of photosynthesis. This could be light intensity, temperature or the amount of chlorophyll.</td>
</tr>
<tr>
<td>Amount of chlorophyll</td>
<td>Chlorophyll is a photosynthetic pigment that absorbs light and allows the reaction between water and carbon dioxide to occur (photosynthesis)</td>
<td>Another factor could limit the rate of photosynthesis. This could be light intensity, temperature or the carbon dioxide concentration.</td>
</tr>
</tbody>
</table>

Rate of photosynthesis

Graph lines A and B: If carbon dioxide concentration is increased from 0.01% to 0.1% then a large increase in rate occurs up to a point.

Graph line A and D: If temperature is increased by 10°C then a slight increase in rate of photosynthesis occurs.

Graph Lines C and D: If temperature is increased by 10°C then a slight increase in rate of photosynthesis occurs. If carbon dioxide concentration and temperature are increased the rate of photosynthesis increases significantly up to a point.

Graph lines C and D: If temperature is increased by 10°C then a slight increase in rate of photosynthesis occurs.

Control conditions in greenhouses to reduce limiting factors can improve crop yields.

Heating

- Used to provide optimum temperatures for maximum plant growth.

Artificial lighting

- Enhances the natural sunlight especially overnight and on cloudy days.

Extra carbon dioxide

- Gas can be pumped into the air inside the greenhouse.

Growers must balance the economics of additional costs of controlling the conditions to maximise photosynthesis with making a profit.
**Response to exercise**

- **Heart rate increases**
  - Top pump oxygenated blood faster to the muscle tissues and cells.
- **Breathing rate and breath volume increase**
  - This increases the amount of oxygen entering the blood stream.

**Respiration**

**AQA GCSE BIOENERGETICS part 2**

**An organism will receive all the energy it needs for living processes as a result of the energy transferred from respiration.**

<table>
<thead>
<tr>
<th>For movement</th>
<th>For keeping warm</th>
<th>For chemical reactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smooth muscle cells</td>
<td>To enable muscles to contract in animals.</td>
<td>To build larger molecules from smaller one.</td>
</tr>
</tbody>
</table>

**Response to exercise**

During exercise the human body reacts to increased demand for energy.

- **Heart rate increases**
  - Top pump oxygenated blood faster to the muscle tissues and cells.
- **Breathing rate and breath volume increase**
  - This increases the amount of oxygen entering the blood stream.

**Respiration**

- **Cellular respiration**
  - An exothermic reaction which is continuously occurring in all living cells.

**Anaerobic respiration**

- **Anaerobic respiration in plant and yeast cells**
  - The end products are ethanol and carbon dioxide. Anaerobic respiration in yeast cells is called fermentation.
  - **Glucose** → **ethanol + carbon dioxide**
  - This process is economically important in the manufacture of alcoholic drinks and bread.

**Aerobic respiration**

- **Respiration with oxygen**
  - Occurs inside the mitochondria continuously.
  - During hard exercise, muscle cells are respiring so fast that blood cannot transport enough oxygen to meet their needs.
  - Glucose is partially oxidised to produce lactic acid which builds up in muscle tissue causing them to become painful and fatigued.
  - **Glucose** → **lactic acid**
  - **Anaerobic respiration releases a much smaller amount of energy than aerobic respiration.**
  - **The incomplete oxidation of glucose causes a build up of lactic acid and creates an oxygen debt.**

- **Aerobic respiration releases a large amount of energy from each glucose molecule.**
  - **Glucose + oxygen** → **carbon dioxide + water**
  - **C₆H₁₂O₆ + O₂ → CO₂ + H₂O**

**Conversion of glucose to starch, glycogen and cellulose.**

- **The formation of lipid molecules from a molecule of glycerol and three molecules of fatty acid.**
- **The use of glucose and nitrate ions to form amino acids which in turn are used to synthesise proteins.**

**Metabolism**

- **Metabolism is the sum of all the reactions in a cell or the body.**
- **The energy transferred by respiration in cells is used by the organism for the continual enzyme controlled processes of metabolism.**
- **Breakdown of excess proteins to form urea for excretion.**

**The extra amount of oxygen required to remove all lactic acids from cells is called the oxygen debt.**

- **Lactic acid builds up in the muscles cells during exercise.**
- **Blood flows through the muscle cells and transports the lactic acid to the liver.**
- **The liver oxidises the lactic acid and converts it back to glucose.**

**Response to exercise**

- **HT only**
  - **Lactic acid builds up in the muscles cells during exercise.**
  - **Blood flows through the muscle cells and transports the lactic acid to the liver.**
  - **The liver oxidises the lactic acid and converts it back to glucose.**
  - **Response to exercise HT only**

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  - **Response to exercise HT only**
**AQA GCSE HOMEOSTASIS AND RESPONSE part 1**

**The human nervous system**

**Cells called receptors**
- Detect stimuli (changes in environment).
- e.g. brain, spinal cord and pancreas that receive information from receptors.

**Coordination centres**

**Effectors**
- Muscles or glands, which bring about responses to restore optimum levels.

**Information from receptors passes along cells (neurones) as electrical impulses to the central nervous system (CNS)**

- The CNS is the brain and the spinal cord.
- Coordinates the response of effectors; muscles contracting or glands secreting hormones.

**Typical motor neurone**

**Synapse (gap where two neurones meet).**

**Reflex arc**

- **Receptor**
  - Detect stimuli.
- **Sensory neurone**
  - Long axon carries impulse from receptor to spinal cord.
- **Synapse**
  - Gap where neurones meet. Chemical message using neurotransmitter.
- **Relay neurone**
  - Allows impulses to travel between sensory and motor neurones in the spinal cord.
- **Motor neurone**
  - Long axon carries impulse from receptor to effector.
- **Effector**
  - Muscle or gland that carries out response.

**Reflex actions are automatic and rapid; they do not involve the conscious part of the brain and can protect humans from harm.**

**Typical motor neurone**

**Synapse (gap where two neurones meet).**

**Receptor**
- Cells in retina
**Coordinator**
- CNS
**Effector**
- Muscles connected to iris
**Response**
- Pupils get smaller

**Stimulus**
- Lights switch on

**Sensory neurone**

**Motor neurone**

**Reflex arc**

**Enables humans to react to their surroundings and to co-ordinate their behaviour**
AQA GCSE HOMEOSTASIS AND RESPONSE PART 2

Homeostasis

The regulation of internal conditions of a cell or organism to maintain optimum conditions for function.

Homeostasis maintains optimal conditions for enzyme action and all cell functions.

Control in the human body

- Blood glucose concentration
- Body temperature
- Water levels

These automatic control systems may involve nervous responses or chemical responses.

Control of blood glucose concentration

- Adrenaline
  - Produced in adrenal glands, increases breathing/heartbeat rate, blood flow to muscles, conversion glycogen to glucose. Prepares body for 'fight or flight'.
  - Negative feedback (HT only)

- Thyroxine
  - Produced in the thyroid gland, stimulates the basal metabolic rate. Important in growth and development.

Blood glucose concentration

- Monitored and controlled by the pancreas

<table>
<thead>
<tr>
<th>Type 1</th>
<th>Type 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pancreas fails to produce sufficient insulin leading to uncontrolled blood glucose levels. Normally treated by insulin injection.</td>
<td>Obesity is a risk factor. Body cells no longer respond to insulin. Common treatments include changing by diet and increasing exercise.</td>
</tr>
</tbody>
</table>

Diabetes

- Type 1
- Type 2

Human endocrine system

- Composed of glands which secrete chemicals called hormones directly into the bloodstream.

- 'Master gland'; secretes several hormones into the blood

- Stimulates other glands to produce hormones to bring about effects.

- The blood carries the hormone to a target organ where it produces an effect. Compared to the nervous system effects are slower but act for longer.

Pituitary gland

<table>
<thead>
<tr>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testes</td>
<td>Ovaries</td>
</tr>
<tr>
<td>Thyroid</td>
<td>Thyroid</td>
</tr>
<tr>
<td>Pineal gland</td>
<td>Pineal gland</td>
</tr>
<tr>
<td>Pituitary gland</td>
<td>Pituitary gland</td>
</tr>
<tr>
<td>Pancreas</td>
<td>Pancreas</td>
</tr>
<tr>
<td>Adrenal gland</td>
<td>Adrenal gland</td>
</tr>
</tbody>
</table>

Endocrine system

- The blood carries the hormone to a target organ where it produces an effect. Compared to the nervous system effects are slower but act for longer.
During puberty reproductive hormones cause secondary sexual characteristics to develop.

**Oestrogen (main female reproductive hormone)**
- Produced in the ovaries. At puberty eggs begin to mature releasing one every 28 days – ovulation.

**Testosterone (main male reproductive hormone)**
- Produced in the testes stimulation sperm production.

**Parthenogenesis**
- Eggs are released from the ovaries without fertilisation, leading to the development of offspring.

**In Vitro Fertilisation (IVF)**
- Involves giving a mother FSH and LH to stimulate the maturation of several eggs.
- The eggs are collected from the mother and fertilised by sperm from the father in a laboratory.
- At the stage when they are tiny balls of cells, one or two embryos are inserted into the mother’s uterus (womb).

**Hormones in human reproduction**

- **FSH and LH** are used as “fertility drugs” to help someone become pregnant in the normal way.
- **Gonadotrophins** stimulate the production of oestrogen and progesterone.
- **Anti-müllerian hormone** (AMH) prevents the development of male sex characteristics in the fetus.

**Hormones produced by the gonads**

- **Oestrogen** (main female reproductive hormone)
  - Produced in the ovaries.
  - Causes uterine lining to develop.

- **Testosterone** (main male reproductive hormone)
  - Produced in the testes.
  - Stimulates growth of male secondary sexual characteristics.

**Menstrual cycle**

- **Follicle stimulating hormone (FSH)**
  - Causes maturation of an egg in the ovary.

- **Luteinising hormone (LH)**
  - Stimulates release of an egg.

- **Oestrogen and progesterone**
  - Maintain uterus lining.

**Contraception**

- **Oral contraceptives**
  - Contain hormones to inhibit FSH production so that no eggs mature.

- **Injection, implant, skin patch**
  - For slow release of progesterone to inhibit the maturation and release of eggs for months or years.

- **Barrier methods**
  - Condoms or diaphragms which prevent sperm reaching the egg.

- **Intrauterine devices**
  - Prevent implantation of an embryo or release a hormone.

- **Spermicidal agents**
  - Kill or disable sperm.

- **Abstaining**
  - Avoiding intercourse when an egg may be in the oviduct.

- **Surgery**
  - Male or female sterilisation.

**Plant hormones**

- **Auxins**
  - Control cell division and ripening of fruits.

- **Ethene**
  - Controls ripening of fruit during storage and transport.

- **Gibberellins**
  - End seed dormancy, promote flowering, increase fruit size.

**Growth and development**

- **Growth**
  - Stems grow away from gravity.

- **Roots**
  - Grow toward gravity.

- **Phototropism**
  - Light breaks down auxins and they become unequally distributed in the shoot. The side with the highest concentration of auxins has the highest growth rate and the shoot grows toward the light.

- **Geotropism**
  - Gravity causes an unequal distribution of auxins. In roots the side with the lowest concentration has the highest growth rate and the root grows in the direction of gravity.

**Gibberellins**

- Important in initiating seed germination.

**Gravity**

- Causes an unequal distribution of auxins. In roots the side with the lowest concentration has the highest growth rate and the root grows in the direction of gravity.

- In new shoots from a seedling the unequal distribution of auxins causes the shoot to grow away from gravity.

**Hormones**

- Used in modern reproductive technologies to treat infertility.

**AQA GCSE HOMEOSTASIS AND RESPONSE PART 3**

**Pituitary gland**

- Thyroid
- Adrenal gland
- Pancreas
- Ovaries
- Testes
- Pineal gland
- Thymus

**Light (phototropism)**

**Gravity (gravitropism)**

**Gibberellins**

**Ethene**

**Auxins**

**Oestrogen and progesterone**

**Potential disadvantages of IVF**

- Emotional and physical stress.
- Success rates are not high.
- Multiple births risk to mother and babies.

**Fertility can be controlled by hormonal and non hormonal methods**

**In Vitro Fertilisation (IVF) treatment.**

**Involves giving a mother FSH and LH to stimulate the maturation of several eggs.**

The eggs are collected from the mother and fertilised by sperm from the father in a laboratory.

The fertilised eggs develop into embryos.

At the stage when they are tiny balls of cells, one or two embryos are inserted into the mother’s uterus (womb).
### Meiosis

- **Gametes are made in reproductive organs (in animals ovaries and testes)**
- **Cells divide by meiosis to form gametes**
- **Gametes join at fertilisation to restore the number of chromosomes**
- **Meiosis leads to non-identical cells being formed while mitosis leads to identical cells being formed**
- **The new cell divides by mitosis. The number of cells increase. As the embryo develops cells differentiate.**
- **DNA and the genome**
  - Genetic material in the nucleus is composed of a chemical called DNA.
  - DNA structure
    - Polymer made up of two strands forming a double helix.
    - Contained in structures called chromosomes. A gene is a small section of DNA on a chromosome. Each gene codes for a sequence of amino acids to make a specific protein.
- **Sexual and asexual reproduction**
  - **Sexual reproduction** involves the fusion of male and female gametes.
  - **Asexual reproduction** involves only one parent and no fusion of gametes.
- **Mutations occur continuously (HT only)**
  - Mutations occur continuously (HT only)
  - In DNA the complementary strands C, A, T, G always link in the same way. C always linked to G on the opposite strand and A to T.
  - Some change the shape and affect the function of proteins e.g. and enzyme active site will change or a structural protein loses its strength.
  - Most do not alter the protein so that its appearance or function is not changed.
  - (HT) Making new proteins (protein synthesis)
    - Composed of chains of amino acids. A sequence of 3 bases codes for a particular amino acid.
    - Protein synthesis (HT only)
      - DNA in the nucleus unravels.
      - Enzymes make a copy of the DNA strand called mRNA.
      - mRNA moves from the nucleus to ribosome in the cytoplasm.
      - Ribosomes translate each 3 bases into amino acids according to mRNA template.
      - Ribosomes link amino acids brought by carrier proteins.
      - A long chain of amino acids form. Their specific order forms a specific protein.
      - A sequence of 3 bases is the code for a particular amino acid. The order of bases controls the order in which each amino acid is assemble to produce a specific protein.

### AQA GCSE INHERITANCE, VARIATION AND EVOLUTION Part 1

- **DNA and the genome**
  - Genetic material in the nucleus is composed of a chemical called DNA.
- **DNA structure**
  - Polymer made up of two strands forming a double helix.
  - Contained in structures called chromosomes. A gene is a small section of DNA on a chromosome. Each gene codes for a sequence of amino acids to make a specific protein.
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### Genetic Inheritance

**Gamete**
- Sex cells produced in meiosis.

**Chromosome**
- A long chain of DNA found in the nucleus.

**Gene**
- Small section of DNA that codes for a particular protein.

**Allele**
- Alternate forms of the same gene.

**Dominant**
- A type of allele – always expressed if only one copy present and when paired with a recessive allele.

**Recessive**
- A type of allele – only expressed when paired with another recessive allele.

**Homozygous**
- Pair of the same alleles, dominant or recessive.

**Heterozygous**
- Two different alleles are present: 1 dominant and 1 recessive.

**Genotype**
- Alleles that are present for a particular feature e.g. Bb or bb.

**Phenotype**
- Physical expression of an allele combination e.g. black fur, blonde hair, blue eyes.

### Genetic Variation

- The genome and its interaction with the environment influence the development of phenotypes.
- Genetic causes (inheritance): variation within the population of a species e.g. hair colour, skin colour, height that can also be affected by environment e.g. nutrition, sunlight.
- Environmental causes (condition they have developed in): a combination of genes and environment.
- All genetic variation arises in mutation, most have no effect on phenotype, some influence but very few determine phenotype.

### Evolution

- Some characteristics are controlled by a single gene e.g. fur colour, colour blindness.
- Genetic causes (inheritance): There is usually extensive genetic variation within the population of a species.
- Environmental causes (condition they have developed in): A combination of genes and environment.
- All genetic variation arises in mutation, most have no effect on phenotype, some influence but very few determine phenotype.
- Very rarely a mutation will lead to a new phenotype which if is suited to environmental change can lead to rapid change in the species.

### Sex Determination

- Ordinary human body cells contain 23 pairs of chromosomes.

### Using a Punnett Square (using mouse fur colour as an example)

<table>
<thead>
<tr>
<th>Parent phenotype (Female)</th>
<th>Parent genotype</th>
<th>What gametes are present in each egg</th>
<th>What gametes are present in each sperm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black fur</td>
<td>BB (homozygous)</td>
<td>B (from female)</td>
<td>b (from male)</td>
</tr>
<tr>
<td>White fur</td>
<td>bb (homozygous)</td>
<td>b (from female)</td>
<td>B (from male)</td>
</tr>
</tbody>
</table>

### AQA GCSE INHERITANCE, VARIATION AND EVOLUTION PART 2

- **Embryo screening**: small piece of developing placenta removed to check for presence of faulty genes.
- **Gene therapy**: replacing the faulty allele in somatic cells with a normal allele.

### Embryo screening / gene therapy issues

<table>
<thead>
<tr>
<th>Economic</th>
<th>Social</th>
<th>Ethical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costly and not 100% reliable.</td>
<td>Not available to everyone (due to cost).</td>
<td>Should only ‘healthy’ embryos be implanted following screening.</td>
</tr>
</tbody>
</table>

### Mutations occur continuously

- Using a family tree: If the father was homozygous dominant then all of the offspring would have the disorder. He must be heterozygous.
- Using a Punnett square: (using mouse fur colour as an example)

### Embryo screening and gene therapy may alleviate suffering

- The probability of a male of female child is 50%. The ratio is 1:1.

### Some disorders are inherited. They are caused by the inheritance of certain alleles

- **Polydactyly**: Caused by inheriting a dominant allele.
- **Cystic Fibrosis**: Caused by inheriting a recessive allele (both parents have to at least carry it).

### A combination of genes and environment

- Variations: differences in the characteristics of individuals in a population may be due to genetic causes (inheritance) and environmental causes (condition they have developed in).
- A combination of genes and environment: There is usually extensive genetic variation within the population of a species e.g. hair colour, skin colour, height that can also be affected by environment e.g. nutrition, sunlight.

### The concept of probability in predicting results of a single gene cross

<table>
<thead>
<tr>
<th>Dominant and recessive allele combinations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominant Represented by a capital letter e.g. B.</td>
</tr>
<tr>
<td>Recessive Represented by a lower case letter e.g. b.</td>
</tr>
</tbody>
</table>

### Crossing two heterozygous mice (Bb)

<table>
<thead>
<tr>
<th>Gametes</th>
<th>BB</th>
<th>Bb</th>
<th>bb</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>B</td>
<td>Bb</td>
<td>B</td>
</tr>
<tr>
<td>b</td>
<td>Bb</td>
<td>Bb</td>
<td>Bb</td>
</tr>
</tbody>
</table>

### Inherited disorders

<table>
<thead>
<tr>
<th>Disorder</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polydactyly</td>
<td>A disorder where a person/animal has extra toes or fingers.</td>
</tr>
<tr>
<td>Cystic Fibrosis</td>
<td>A disorder of the cell membrane. Patients cannot control the viscosity of their mucus.</td>
</tr>
</tbody>
</table>

### Genetic disorders

- **Polydactyly**: Caused by inheriting a dominant allele.
- **Cystic Fibrosis**: Caused by inheriting a recessive allele (both parents have to at least carry it).

### Embryo screening

- Embryo screening: small piece of developing placenta removed to check for presence of faulty genes.
- Using a family tree: If the father was homozygous dominant then all of the offspring would have the disorder. He must be heterozygous.

### Gene therapy

- Gene therapy: replacing the faulty allele in somatic cells with a normal allele.
- Using a family tree: If the father was homozygous dominant then all of the offspring would have the disorder. He must be heterozygous.

### Genetic inheritance

- The alleles present, or genotype operate at a molecular level to develop characteristics that can be expressed as a phenotype.
- Most characteristics are a result of multiple genes interacting.

### Economic
- Costly and not 100% reliable.

### Social
- Not available to everyone (due to cost).

### Ethical
- Should only ‘healthy’ embryos be implanted following screening.
Evolution

A change in the inherited characteristics of a population over time through the process of natural selection.

The theory of evolution by natural selection.

Species of all living things have evolved from simple life forms that first developed 3 billion years ago.

Through natural selection of variants (genotypes) that give rise to phenotypes best suited to their environment or environmental change e.g. stronger, faster. This allows for variants to pass on their genotype to the next generation.

If two populations of one species become so different in phenotype that they can no longer interbreed to produce fertile offspring they have formed two new species.

AQA GCSE INHERITANCE VARIATION AND EVOLUTION PART 3

Selective breeding

Choosing parents with the desired characteristics from a mixed population

Chosen parents are bred together.

From the offspring those with desired characteristics are bred together.

Repeat over several generations until all the offspring show the desired characteristics.

Selective breeding can lead to “breeding” where some breeds are particularly prone to disease or inherited defects e.g. British Bulldogs have breathing difficulties.

Genetic engineering

Genetically modified crops (GMO)

Crops that have genes from other organisms

To become more resistant to insect attack or herbicides.

To increase the yield of the crop.

Genetic engineering process (HT only)

1. Enzymes are used to isolate the required gene.

2. Gene is inserted into a vector – bacterial plasmid or virus.

3. Vector inserts genes into the required cells.

4. Genes are transferred to plants/animals/microbes at an early stage of development so they develop the required characteristics.

Genes from the chromosomes of humans or other organisms can be “cut out” and transferred to the cells of other organisms.

Concern: effect of GMO on wild populations of flowers and insects.

Concern: effect of GMO on human health not fully explored.

Modern medical is exploring the possibility of GM to overcome inherited disorders e.g. cystic fibrosis.

Evolutionary trees are a method used by scientists to show how organisms are related.

Use current classification data for living organisms and fossil data for extinct organisms.

Classification of living organisms

Evolutionary trees are a method used by scientists to show how organisms are related.

Choosing characteristics

Desired characteristics are chosen for usefulness or appearance.

Disease resistance in food crops.

Animals which produce more meat or milk.

Domestic dogs with a gentle nature.

Large or unusual flowers.

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Evidence for evolution

Fossils and antibiotic resistance in bacteria provide evidence for evolution.

Fossils
- ‘remains’ of ancient organisms which are found in rocks
  - Parts of organism that have not decayed as necessary conditions are absent.
  - Parts of the organism replaced by minerals as they decay.
  - Preserved traces of organisms such as footprints, burrows and rootlet traces.

Antibiotic resistant bacteria
- Mutations produce antibiotic resistant strains which can spread
- Resistant strains are not killed.
- Strain survives and reproduces.
- People have no immunity to strain and treatment is ineffective.

Extinction
- When no members of a species survive
  - Due to extreme geological events, disease, climate change, habitat destruction, hunting by humans.
  - Fossils tell scientists how much or how little different organisms have changed over time.

Classification of living organisms

Carl Linnaeus classified living things

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Animalia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phylum</td>
<td>Chordata</td>
</tr>
<tr>
<td>Class</td>
<td>Mammalia</td>
</tr>
<tr>
<td>Order</td>
<td>Primates</td>
</tr>
<tr>
<td>Family</td>
<td>Hominidae</td>
</tr>
<tr>
<td>Genus</td>
<td>Homo</td>
</tr>
<tr>
<td>Species</td>
<td>sapiens</td>
</tr>
</tbody>
</table>

Organisms are named by the binomial system of genus and species. Humans are Homo sapiens.

Evolution is widely accepted. Evidence is now available as it has been shown that characteristics are passed on to offspring in genes.
**AQA GCSE ECOLOGY PART 1**

**Interdependence**
Species depend on each other for food, shelter, pollination, seed dispersal etc. Removing a species can affect the whole community.

**Competition**
Plants in a community or habitat compete with each other for light, space, water and mineral ions.
Animals compete with each other for food, mates and territory.

**Adaptations**
Organisms adapt to conditions where they normally live. Adaptations may be structural, behavioural or functional.

**Levels of organisation**
- **Abiotic factors**
- **Biotic factors**

**Factors affecting rate of decay**
- **Temperature, water, oxygen**
  Increase the rate of decay. In enzyme controlled reactions raising the temperature too high will denature the enzymes.

**Decomposition and material cycling**
- Bacteria respire when breaking down dead organisms releasing CO₂.
- Anaerobic decay in biogas generators produces methane gas, used as a fuel.
- Decomposition and material cycling: Bacteria respire when breaking down dead organisms releasing carbon.
- Dead organisms decayed by bacteria and fungi releasing carbon.

**Materials are recycled to provide the building blocks for future organisms**
Materials are recycled to provide the building blocks for future organisms.

**THE CARBON CYCLE**
- CO₂ taken in during photosynthesis.
- Organisms respire releasing CO₂.
- Plants in a community or habitat compete with each other for light, space, water and mineral ions.
- Animals compete with each other for food, mates and territory.

**EXAMPLE:** climate change is leading to more dissolved CO₂ in oceans lowering the pH of the water affecting organisms living there.

**Abiotic**
- Non-living factors that affect a community
  - Living intensity.
  - Availability of food.
  - Temperature.
  - Moisture levels.
  - Soil pH, mineral content.
  - Wind intensity and direction.
  - Carbon dioxide levels for aquatic organisms.

**Biotic**
- Living factors that affect a community
  - New predators arriving.
  - New pathogens.
  - One species outcompeting so numbers are no longer sufficient to breed.

**Adaptations**
- Plants
  - Cactus in dry, hot desert
  - No leaves to reduce water loss, wide deep roots for absorbing water.
- Animals
  - Polar bear in extreme cold artic
  - Hollow hairs to trap layer of heat. Thick layer of fat for insulation.
- Extremophiles
  - Deep sea vent bacteria
  - Populations form in thick layers to protect outer layers from extreme heat of vent.

**Food chains**
- Feeding relationships in a community
  - Producer
  - Primary consumer
  - Secondary consumer
  - Tertiary consumer

**Levels of organisation**
In a stable community the numbers of predators and prey rise and fall in cycles.

**Ecosystem**
- Environment: The conditions surrounding an organism; abiotic and biotic.
- Habitat: Place where organisms live e.g. woodland, lake.
- Population: Individuals of a species living in a habitat.
- Community: Populations of different species living in a habitat.

**Interdependence and competition**
- Populations form in thick layers to protect outer layers from extreme heat of vent.
Levels of CO₂ and methane in the atmosphere are increasing. Decreased land availability from sea level rise, temperature rise damages delicate habitats, extreme weather events harm populations of plants and animals.

Global warming

There is a global consensus about global warming and climate change based on systematic reviews of thousands of peer reviewed publications.

Global Warming Predictions

AQA GCSE ECOLOGY PART 2

Maintaining biodiversity

Human activity can have a positive impact on biodiversity

Scientists and concerned citizens

Put in place programmes to reduce the negative impacts of humans on ecosystems and biodiversity

Breeding programmes for endangered species.

Protection and regeneration of rare habitats.

Reintroduction of field margins and hedgerows in agricultural areas where farmers grow only one type of crop.

Reduction of deforestation and CO₂ emissions by some governments.

Recycling resources rather than dumping waste in landfill.

Some of the programmes potentially conflict with human needs for land use, food production and high living standards.
**Biodiversity**

Biodiversity is the variety of all different species of organisms on Earth, or within an ecosystem.

- **Maintain a great biodiversity**
  - Ensures the stability of ecosystems
  - Future of human species

**Human activity can have a negative impact on biodiversity**

- By reducing the dependence on one species on another for food, shelter, maintenance of the physical environment.
- Many human activities are reduction biodiversity and only recently measures have been taken to stop it.

**Waste, land use and deforestation**

- Rapid growth in human population and higher standard of living
  - More resources used and more waste produced.
  - Pollution in water; sewage, fertiliser or toxic chemicals.
  - Pollution in air; smoke or acidic gases.
  - Pollution on land; landfill and toxic chemicals.

- Land use
  - Humans reduce the amount of land and habitats available for other plants, animals and microorganisms.
    - Building and quarrying.
    - Farming for animals and food crops.
    - Dumping waste.
    - Destruction of peat bogs to produce cheap compost for gardeners/farmers to increase food production.
    - The decay or burning of peat release CO₂ into the atmosphere.

**Experimental methods**

- Quadrats
  - Organisms are counted within a randomly placed square

- Transects
  - Organisms are counted along a belt (transect) of the ecosystem.

**Processing data**

- **Median**
  - Middle value in a sample.

- **Mode**
  - Most occurring value in a sample.

- **Mean**
  - The sum of all the value in a sample divided by the sample number.

**Large scale deforestation**

- Provide land for cattle and rice fields, grow crops for biofuels.

Deforestation reduces biodiversity and removes a sink for increasing the amount CO₂ in the atmosphere.

This conflicts with conserving peat bogs and peatlands as habitats for biodiversity and reduce CO₂ emissions.